Metrology for Climate Action

13 October 2021

R.I. Wielgosz

Bureau International des Poids et Mesures

The BIPM: An International Organization for Metrology

"The BIPM is an intergovernmental organization established by the Metre Convention, through which Member States act together on matters related to measurement science and measurement standards".

- **Supervisory Body: International Committee for Weights and Measures (CIPM)**
- **Technical Committees: Consultative Committees**
- **Offices and Laboratories: Sèvres, France**

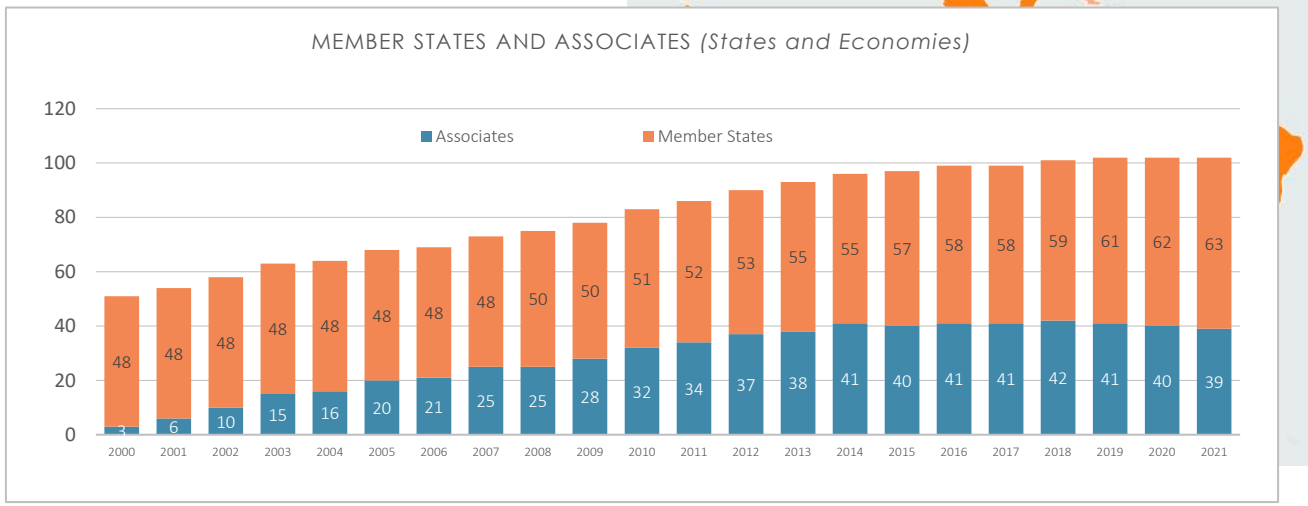




Member States and Associates *(as of June 2021)*

- 63 Member States* and
- 39 Associates of the CGPM
(States and Economies)

New Member State: Estonia
New Associate of the CGPM: Cambodia
New signatory of the CIPM MRA: NMC (Cambodia)
Excluded Associate: Zimbabwe



110 of the 193 states listed by the UN participate in the BIPM's activities, covering around 98 % of the world's GDP according to 2020 IMF.

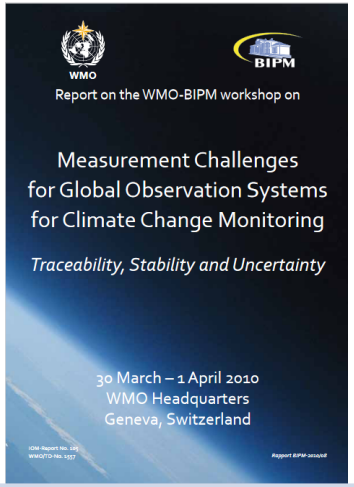
The Republic of Estonia became a Member State on 19 January 2021.

The Kingdom of Cambodia became an Associate on 1 January 2021.

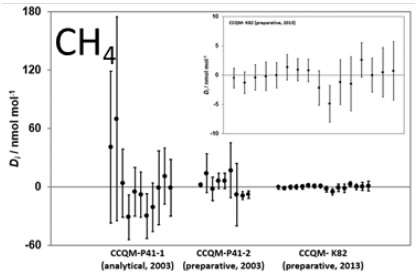
Timeline of BIPM activities for Earth Observation and Climate

2002 — **Working arrangement with WMO**

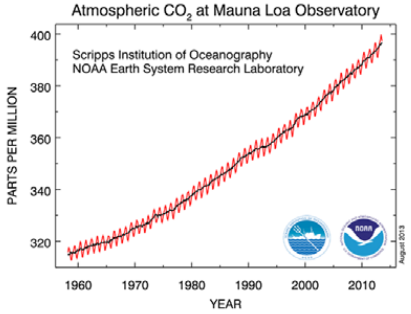
2010 — **WMO-BIPM Workshop**



2010 — **WMO signs CIPM-MRA**



2015 — **Global to Urban Carbon Measurement Workshop**



2021 — **CIPM Sectorial Task Group on Environment and Climate Change**

2022 — **Metrology for Climate Action**

BIPM WORLD METEOROLOGICAL ORGANIZATION

Metrology for Climate Action Workshop 2022

Hosted by the BIPM and WMO
26-30 September 2022

Progress in Metrology for Earth Observation since 2010

THEN

QA4EO was endorsed by CEOS in 2008.
It set the aim to bring SI traceability into Earth Observation

Focus on traceability for pre- and post-launch calibration of satellite sensors

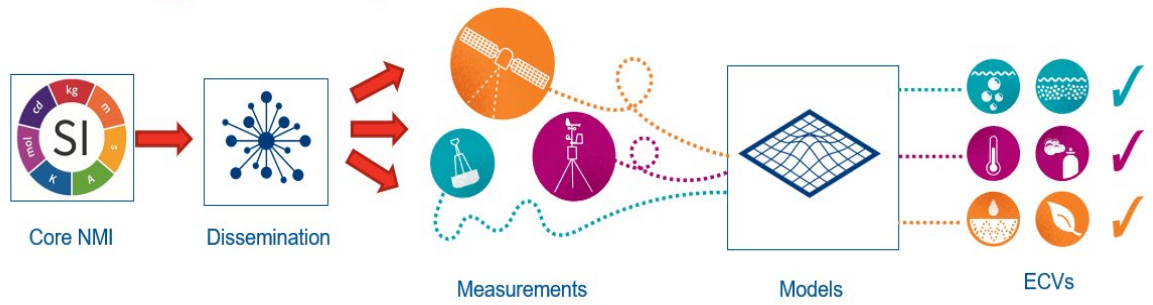
2010 Recommendations

- Better communicate the tools of the metrologists (measurement comparisons, robust uncertainty analysis, quality systems, language) as embedded for example in QA4EO to meteorologists through training, real-life demonstrations, collaboration, and compelling examples of the benefits.
- Perform quantitative analysis of the performance, over the long term, of the piecemeal renormalization approaches versus on-orbit traceability to better inform agencies on the priority for achieving traceability on-orbit for climate missions (to be coordinated through CEOS).
- Include NMI experts in the pre- and post-launch calibration of satellite sensors.
- Enable traceability requirements for pre- and post-launch sensor calibration and post-launch validation activities to be met.
- Maintain and improve *in situ* systems, such as buoy and ship-based infrared radiometer networks independent of individual satellite instrument programmes to ensure the ability to link climate records across potential satellite data gaps.

NOW

- QA4EO now widely accepted
- ESA and NASA reference QA4EO in calibration activities
- NPL, NIST, PTB and other NMIs actively engaged in supporting pre and post launch calibration of sensors

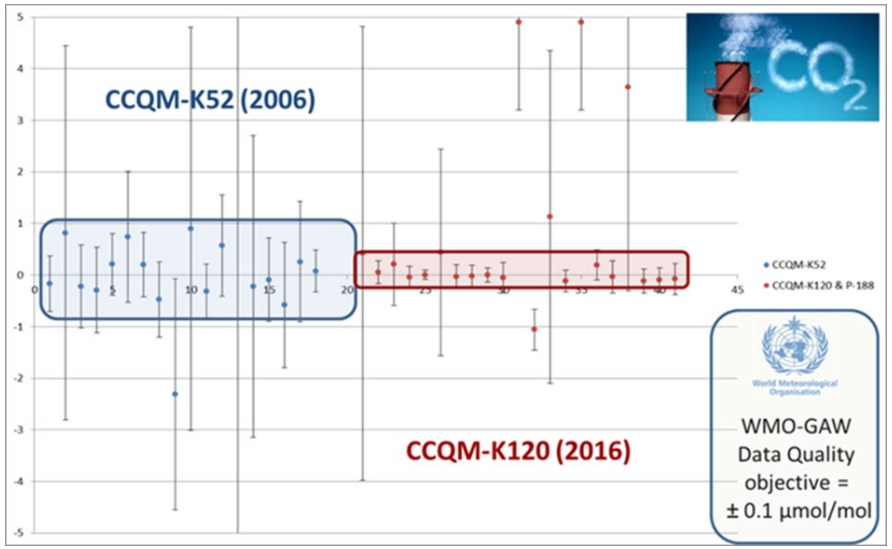
FUTURE

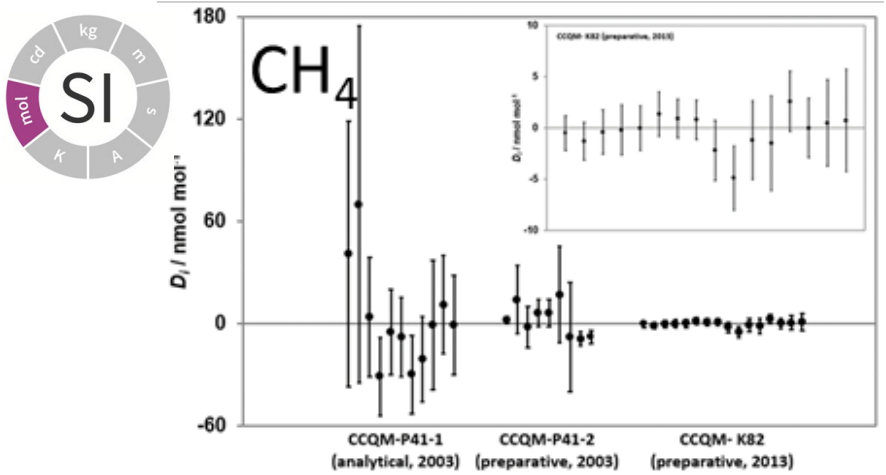


Moving to applications: confidence in information

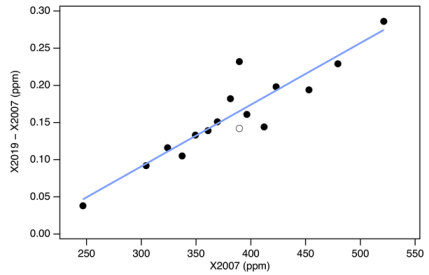
Progress in GHG Measurement Science since 2010

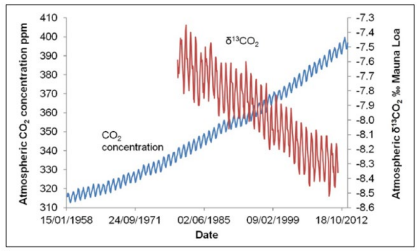
On-going comparisons for major GHG gases





Revision of the World Meteorological Organization Global Atmosphere Watch (WMO/GAW) CO_2 calibration scale





CCQM Working Groups

Select

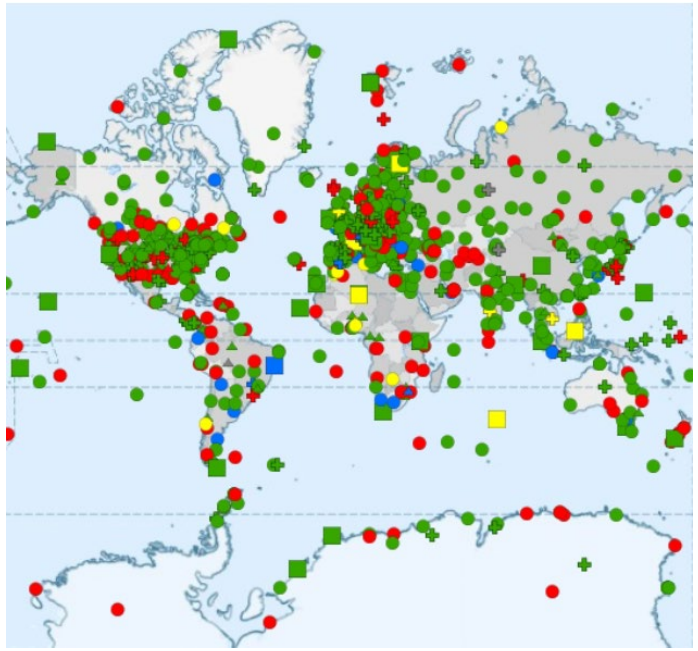
CCQM-GAWG Task Group on GHG Scale Comparisons (CCQM-GAWG-TG-GHG)

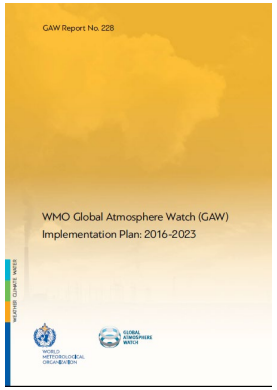
a. To document procedures for CO_2 in air scale establishment, maintenance and value transfer, validated by measurements performed by members of the Task Group;

b. To develop a comparison protocol to enable the mathematical relationship between independently held sets of primary CO_2 in air standards to be developed, targeting the dissemination of standards on related scales with consistency at the 0.02 µmol/mol level;

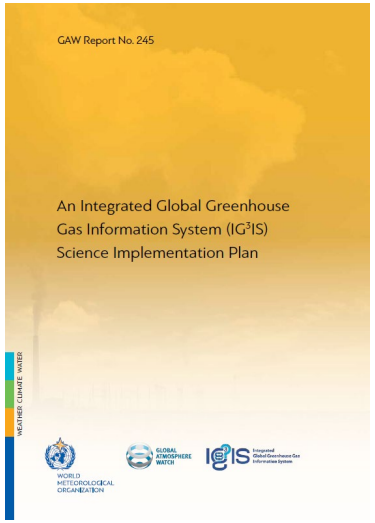
c. To develop a protocol for an on-going comparison that will demonstrate the maintenance or divergence of the relationship between scales based on different sets of primary CO_2 in air standards over decadal time periods;

Developments in Measurements related to GHG Mitigation since 2015





Global Background GHG measurement network



https://doi.org/10.1038/s41467-020-20871-0 OPEN

Under-reporting of greenhouse gas emissions in U.S. cities

Kevin Robert Gurney[1✉], Jianming Liang[2], Geoffrey Roest[1], Yang Song[1], Kimberly Mueller[3] & Thomas Lauvaux[4]

Cities dominate greenhouse gas emissions. Many have generated self-reported emission inventories, but their value to emissions mitigation depends on their accuracy, which remains untested. Here, we compare self-reported inventories from 48 US cities to independent estimates from the Vulcan carbon dioxide emissions data product, which is consistent with atmospheric measurements. We found that cities under-report their own greenhouse gas emissions, on average, by 18.3% (range: −145.5% to +63.5%) – a difference which if extrapolated to all U.S. cities, exceeds California's total emissions by 23.5%. Differences arise

Standardized methods for in situ measurement of GHGs in an urban environment

Metrology for Climate Action 2022

BIPM WORLD METEOROLOGICAL ORGANIZATION

Metrology for Climate Action Workshop 2022

Hosted by the BIPM and WMO

26-30 September 2022

The aims of this workshop are to present progress and identify requirements for further development of advanced measurements, standards, reference data, comparisons, calibrations and metrological techniques to support the physical science basis for and adaptation to climate change, as well as efforts to mitigate greenhouse gas emissions.

Theme 1: Metrology in support of the physical science basis of climate change and climate observations

Theme 2: Metrology in support of greenhouse gas mitigation efforts

https://www.bipm.org/en/bipm-workshops/bipm-wmo-workshop-2022

How to get involved: Participation

Theme 1: Metrology in support of the physical science basis of climate change and climate observations

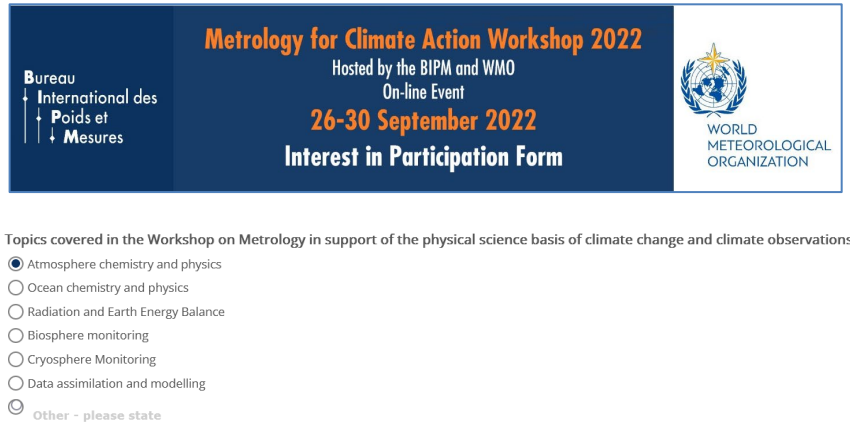
The topics (provisional) covered within the theme are Metrology in support of:

- Atmosphere chemistry and physics
- Ocean chemistry and physics
- Radiation and Earth Energy Balance
- Biosphere monitoring
- Cryosphere Monitoring
- Data assimilation and modelling

Other topics under consideration:

- Reference networks and fiducial reference measurements
- Extreme climate monitoring
- Traceability of observations in developing economies
- Historical climate and paleoclimatology

Register your interest in participation



https://www.bipm.org/en/bipm-workshops/bipm-wmo-workshop-2022

How to get involved: Participation

Theme 2: Metrology in support of greenhouse gas mitigation efforts

The topics (provisional) covered within the theme are Metrology in support of:

- GHG Measurement Scales: establishment, maintenance, and value transfer
- Improving national emission inventories
  - Application of atmospheric concentration measurements for emission estimates
  - Measurements for Land Use, Land Use Change, and Forestry (LULUCF)
- Targeting and tracking emissions at local scales: cities, states and provinces
- Quantifying carbon credits and other climate finance need for standards
- Meeting new sensor requirements: surface-based, airborne and space-borne

Register your interest in participation


Bureau International des Poids et Mesures

Metrology for Climate Action Workshop 2022
Hosted by the BIPM and WMO
On-line Event
26-30 September 2022
Interest in Participation Form

WORLD METEOROLOGICAL ORGANIZATION

Topics covered in the Workshop on Metrology in support of greenhouse gas mitigation efforts: *

- ○ GHG Measurement Scales: establishment, maintenance and value transfer
- ○ Improving national emission inventories - Application of atmospheric concentration measurements for emission estimates
- ○ Improving national emission inventories - Measurements for Land Use, Land Use Change, and Forestry (LULUCF)
- ○ Targeting and tracking emissions at local scales: cities, states and provinces
- ○ Quantifying carbon credits and other climate finance needs for standards
- ○ Meeting new sensor requirements: surface-based, airborne and space-borne
- ○ Other - please state

https://www.bipm.org/en/bipm-workshops/bipm-wmo-workshop-2022

Format of the Workshop

BIPM WORLD METEOROLOGICAL ORGANIZATION

Metrology for Climate Action Workshop 2022

Hosted by the BIPM and WMO

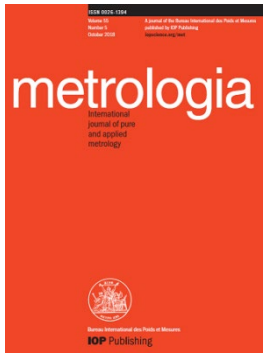
26-30 September 2022

The workshop will be held **online** and incorporate an introductory plenary session, an open call and sessions for papers and posters and meetings of topic specific working groups to develop recommendations.

- 26 September 2022: Introductory Plenary Session
- 27-28 September 2022: Virtual Paper and Poster Presentations
- 29-30 September 2022: Topic Specific Recommendation Development Sessions

Metrology for Climate Action

***Metrologia* 'Focus on' issue**



Invited Review Papers and open call for research papers

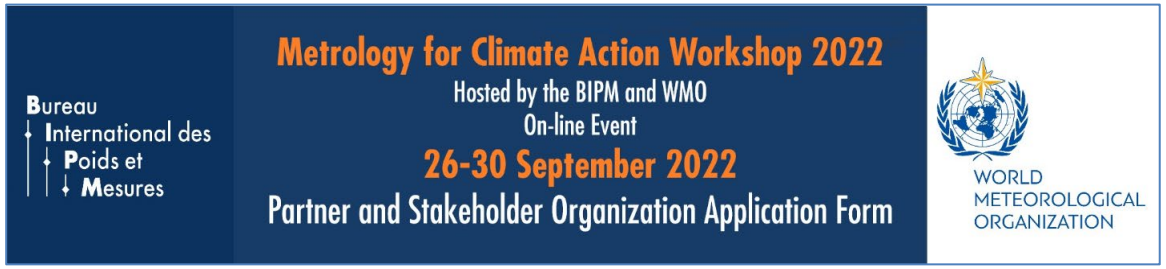
Metrological challenges for measurements of key climatological observables: oceanic salinity and pH, and atmospheric humidity. Part 1: overview
R Feistel *et al* 2016 *Metrologia* **53** R1
+ Open abstract View article PDF

Metrological challenges for measurements of key climatological observables Part 2: oceanic salinity
R Pawlowicz *et al* 2016 *Metrologia* **53** R12
+ Open abstract View article PDF

Metrological challenges for measurements of key climatological observables. Part 3: seawater pH
A G Dickson *et al* 2016 *Metrologia* **53** R26
+ Open abstract View article PDF

https://www.bipm.org/en/bipm-workshops/bipm-wmo-workshop-2022

How to get involved: Partners and Stakeholder Organizations



Partner Organizations

Organizations wishing to apply for Partner status for the BIPM-WMO workshop shall:

a. have activities related to the workshop themes and aligned to aims of workshop;
b. be prepared to provide support for the meeting organization and financial support for meeting platforms;
c. promote the workshop and solicit submissions of posters and presentations from their organization and relevant networks;
d. provide experts for peer reviews of submitted abstracts for papers/presentations;
e. be willing to promote the outcomes of the workshop.

Stakeholder Organizations

Organizations wishing to apply for Stakeholder status for the BIPM-WMO workshop shall:

a. have activities that are consistent with the workshop aims;
b. be willing to promote the outcomes of the workshop.

https://www.bipm.org/en/bipm-workshops/bipm-wmo-workshop-2022

Acknowledgements

Current Steering Committee Members:

Anthony Rea (WMO)
Dolores del Campo (BIPM, CIPM)
Isabelle Ruedi (WMO)
Emma Woolliams (NPL, Chair EMN Climate and Ocean Observation)
James Whetstone (NIST)
Phil DeCola (IG3IS)
Robert Wielgosz (BIPM)

Workshop Coordinator: Edgar Flores (BIPM)

Recruitment of additional steering committee members on-going